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New occurrences of bryophytes species in Southern Brazil: bryodiversity still scarcely known

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Abstract
Rio Grande do Sul is the southern state of Brazil and includes 569 taxa of bryophytes, a rich diversity promoted by its geographical position. All recent floristic inventories in the state recorded new occurrences of species, indicating that the diversity of bryophytes may be underestimated. Through floristic inventories carried out between 2016 and 2019, new occurrences of 16 species, included in seven families and 11 genera, were identified. Seven of them are also new records for the Southern Brazil. Bryophyta is represented by five species, four genera and four families, and Marchantiophyta by 11 species, seven genera, and three families.

Keywords
Atlantic Forest, distribution pattern, liverworts, mosses, protected areas, restinga.

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Introduction

Brazil encompasses 1,524 species of bryophytes, making it the richest country in the Neotropics (Costa and Peralta 2015). The recently published Brazilian list of the bryoflora has immensely contributed to the knowledge of bryophytes distributions throughout the country (Costa and Peralta 2015), although there are still gaps as the Rio Grande do Sul state (Bordin and Yano 2010).

Rio Grande do Sul is the southern state of Brazil, located in the temperate southern zone between the Tropic of Capricorn and the Antarctic Circle, with an average latitude of 30°S and territorial area of 281,707 km² (Rambo 1956). According to the Köppen system, the climate fits as humid temperate, with rainfall during all months of the year and average temperature between 22 °C and 3 °C (Moreno 1961). The state includes two phytogeographic domains: the Pampa, which occupies 63% of the territory and does not occur in other Brazilian states, and the Atlantic Forest, which occurs from Rio Grande do Norte to Rio Grande do Sul. The Atlantic Forest remains preserved in only 7% of its original area, one of the reasons why it is considered a biodiversity hotspot (SOS Mata Atlântica 2019).

According to Sehnem (1953), the bryological flora of Rio Grande do Sul is rich and varied due to the geographical position of the state. It is in a privileged floristic situation since it has suffered irradiations of the

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Neotropical flora that immigrated with the hygrophilous forest, the grassy flora of Central Brazil, the southern Pampa and the Austral–Antarctic flora.

The current knowledge includes 569 taxa recorded in the state, approximately 37% of the Brazilian species (Costa and Peralta 2015). However, this number represents only a few sampled areas, especially in the Encosta Superior and Inferior do Nordeste and Campos de Cima da Serra, and some in the regions of Litoral, Campanha, Missões, Alto Uruguai and Planalto Médio (Bordin and Yano 2010). Bordin and Yano (2010) had listed 760 taxa for the state, but some dubious names and species with uncertain collection site were included.

Bryological studies of Rio Grande do Sul were resumed in 2006 and, since then, new occurrences have been frequently published in floristic papers, including anthropized and degraded places (e.g. urban areas), of both Atlantic Forest (Yano and Bordin 2006, 2015; Bordin and Yano 2009a, 2009b; Weber et al. 2015) and Pampa (Bordin et al. 2020; Aires et al. 2020; Peralta et al. 2020).

Peralta et al. (2020) recorded a new family and genus for Brazil, collected in the Pampa of Rio Grande do Sul. This underlines not only the importance of the continuity of floristic studies, but also the insufficient knowledge of the bryoflora in the state, indicating that the present number of species can be underestimated. The aim of this study is to present a compilation of new records of bryophytes for Rio Grande do Sul and the southern region of Brazil, identified in a recently collected material.

Methods

Floristic inventories were carried out between the years 2016 and 2019 on a private property located in the Campos de Cima da Serra region, and in two protected areas on the northern coast of Rio Grande do Sul (RS), Brazil (Fig. 1).

The Environmental Protection Area of Morro de Osório (APA Morro de Osório) is located in the municipality of Osório, on the northern coast of RS (29°49′41″S, 050°14′58″W) and has an altitude between 50 to 398 m. The APA Morro de Osório has 6,896.75 ha, with typical vegetation of the transition zone between the Dense Ombrophilous formations and Semi-deciduous Seasonal Forest. A large part of this area was deforested for agricultural purposes, and only isolated areas of the original vegetal covering still remains (Osório 2006).

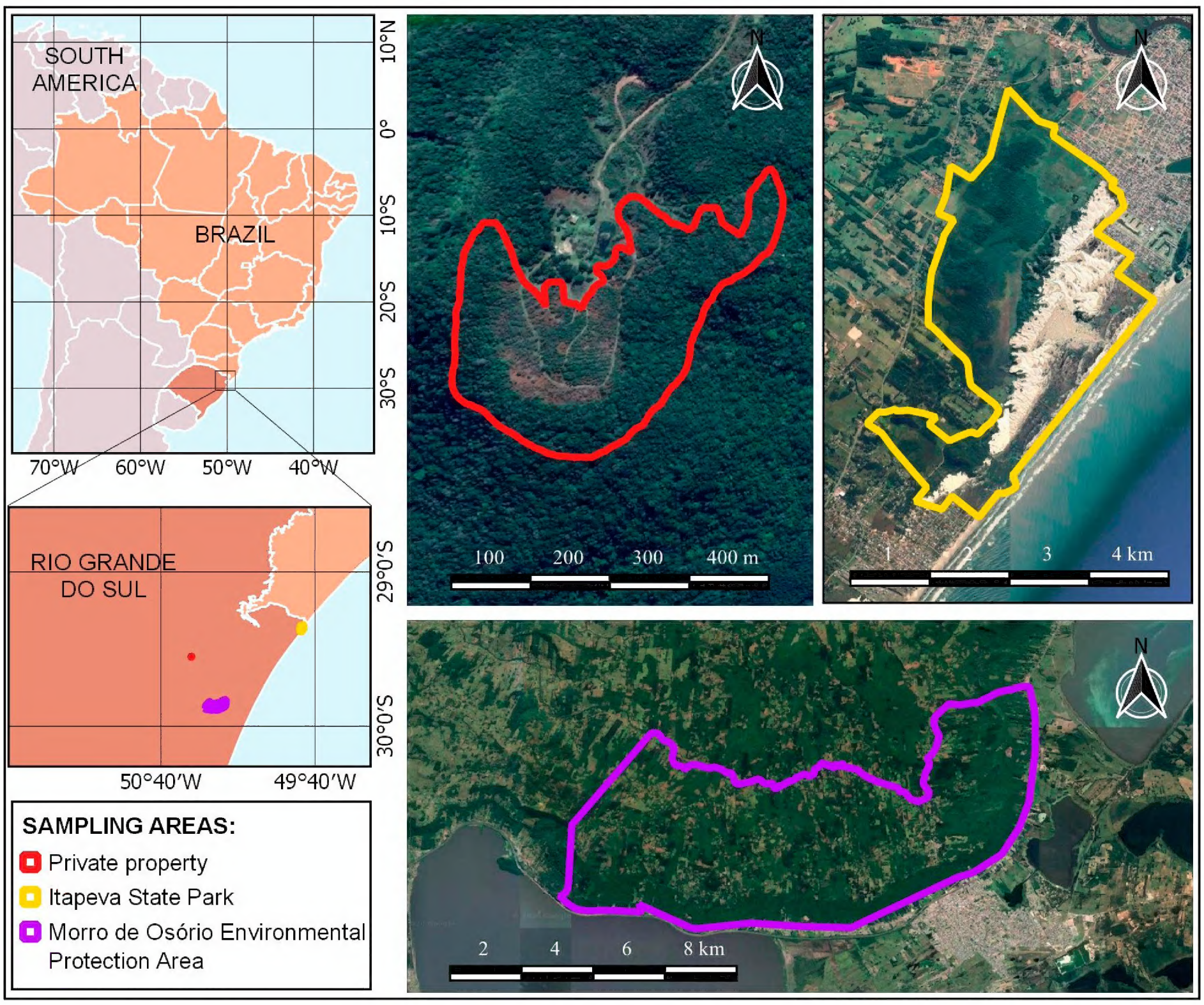

Figure 1. Map of the sampling areas (right) location in Brazil and the state of Rio Grande do Sul (left).

The Itapeva State Park is in the municipality of Torres, north coast of the state (29°21′51″S, 049°45′03″W), and has an approximate area of 1.000 ha. Its vegetation is classified as pioneer restinga formations, with different phytophysiognomies: front dune vegetation, wetlands, humid and sandy fields, and sandy and swamp forest (Duarte and Bencke 2006).

The private property (29°32′50.00″S, 050°28′20.53″ W) located in Campos de Cima da Serra, municipality of São Francisco de Paula, includes areas of plateau and hillside, originally covered by Mixed Ombrophilous Forest and Ecotones with Semi deciduous Seasonal Forest, with altitudes ranging from 700 to 900 m (Teixeira et al. 1986).

The floristic inventories followed the standard collections methods and covered all available substrates (Filgueiras et al. 1994; Frahm 2003). Species identification were carried out at the Laboratory of Biology and Conservation of the State University of Rio Grande do Sul – Litoral Norte (UERGS), using stereomicroscope and optical microscope, specialized bibliography: Costa (2008); Bordin and Yano (2011, 2013); Reiner-Drehwald (2000); Ochi (1980); Sharp et al. (1994)and consultation of the herbarium materials and specialists. The samples were incorporated into the collection of Dr Ronaldo Wasum Herbarium of the UERGS (HERW).

The taxonomic classification followed Crandall-Stotler et al. (2009) for Marchantiophyta, and Goffinet et al. (2009) for Bryophyta. Geographical distribution of the species in Brazil and the occurrence in phytogeographic domains followed the data available in Flora do Brasil (2020).

Results

Sixteen species distributed in seven families and 11 genera were identified as new occurrences for the state of Rio Grande do Sul. Bryophyta is represented by five species, in four genera and four families, and Marchantiophyta by 11 species, in seven genera and three families.

Six species are recorded for the first time in the South Region of Brazil. Four were previously recorded from São Paulo (*Cylindrocolea rhizantha* (Mont.) R. M. Schust., *Drepanolejeunea fragilis* Bischl., *Lejeunea bermudiana* (A. Evans) R. M. Schust. and *Bryum atenense* Williams); one from Rio de Janeiro (*Frullanoides corticalis* (Lehm. & Lindenb.) van Slageren); and one from the Amazon Region (*Fissidens prionodes* Mont.) (Flora do Brasil 2020; Bordin and Yano 2013). With this new record for Rio Grande do Sul, *Fissidens prionodes* and *Frullanoides corticalis* changed their distribution pattern from restricted to moderate.

Bryophyta
Bryaceae

***Bryum atenense* Williams**
Figures 2A, 5A

Material examined. BRAZIL • 1 specimen; Rio Grande do Sul, Torres, Itapeva State Park; 29°21′51″S, 049°45′03″W; 9 Jan. 2019; T.S. Dewes et al. leg.; restinga sandy forest, sandy substrate; HERW 2158.

Identification. Gametophyte small (2–5 mm long), leaf small (0.5–1.2 mm long), leaf margin flat, with a row of one or two elongated cells; apical cells thin and rhomboids; basal cells rectangular; alar cells quadratic; costa strong, long-excurrent; capsule horizontal to suberect.

Phytogeographic domain. Cerrado, Caatinga, Pantanal, and Atlantic Forest.

Comments about geographic distribution. *Bryum atenense* has a disjunct geographic distribution in Brazil, occurring in all biomes except the Amazon and Pampa. This new record is the first for the South Region of Brazil (Fig. 5A), expanding the knowledge about its geographical distribution and indicating that the species may also occur in the other states of the region.

Dicranaceae

***Campylopus surinamensis* Müll. Hal.**
Figures 2B–E, 5A

Material examined. BRAZIL • 1 specimen; Rio Grande do Sul, Torres, Itapeva State Park; 29°21′51″S, 049°45′03″W; 25 Oct. 2018; T.S. Dewes et al. leg.; restinga sandy forest, on the hill trail soil; HERW 2209.

Identification. Gametophyte erect with a basal tuft, a reddish tuft, leaf pressed along the stem and a terminal comal tuft, a cross-section of the costa with a ventral layer of hyalocysts, a layer of stereids on the dorsal side, a median row of guide cells, and lamellae with a height cell.

Phytogeographic domain. Amazon, Cerrado, Atlantic Forest, and Pantanal.

Comments about geographic distribution. *Campylopus surinamensis* is broadly distributed throughout Brazil, and this new occurrence in Rio Grande do Sul (Fig. 5A) was expected. It is possible that this species also occurs in the Biome Pampa, due to its wide distribution, but more collection effort is necessary in this area.

Fissidentaceae

***Fissidens prionodes* Mont.**
Figures 2H–I, 5A

Material examined. BRAZIL • 1 specimen; Rio Grande do Sul, Osório, APA Morro de Osório; 29°51′39″S, 050°16′49″W; 7 Feb. 2019; M. Ferri et al. leg.; stream spring, on tree trunk base; HERW 2425.

Identification. Gametophyte small to medium (2–4 mm long), leaf elimbated, linear-lanceolate, acute apex; costa excurrent; cells rounded to hexagonal, irregular, inflated, unipapillose; sporophyte terminal, in the main branch. It differs from *F. allionii* Broth. by presenting

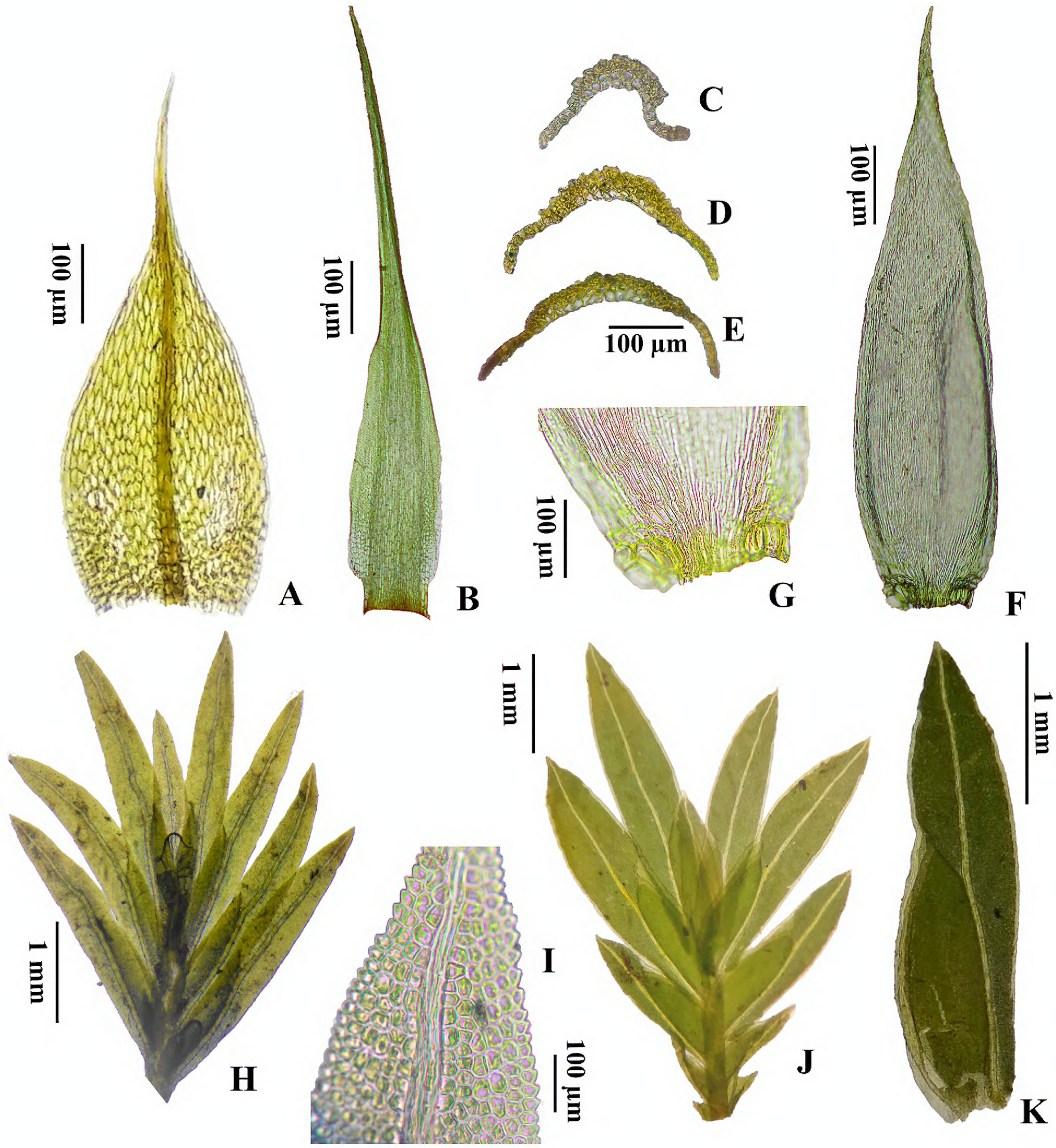

Figure 2. A. *Bryum atenense*, leaf. **B–E.** *Campylopus surinamensis*. **B.** Leaf. **C.** Leaf cross section at apex. **D.** Leaf cross section at median region of the leaf. **E.** Leaf cross section at base. **F–G.** *Isopterygium subbrevisetum*. **F.** Leaf. **G.** Detail of the alar cells. **H, I.** *Fissidens prionodes*. **H.** Gametophyte. **I.** Detail of the cells. **J, K.** *Fissidens pseudoplurisetus*. **J.** Gametophyte. **K.** Leaf.

filaments with costa wider, percurent and sporophytes in lateral branches.

Phytogeographic domain. Amazon.

Comments about geographic distribution. *Fissidens prionodes* was previously recorded only for the Amazon region: Bolivia, Colombia, Guyana, French Guiana, Suriname, Venezuela and Brazil (Acre, Amazonas, Mato Grosso, Pará, Rondônia, Roraima). It can be found from the sea level up to 400 m a.s.l., and on the ground, termite mounds, or trunks in decomposition (Pursell 2007; Bordin and Yano 2013). In the present study, in turn, it was collected in the forest, near waterfalls, and on ravine soil. This new record (Fig. 5A) represents a discontinuity in the distribution of the species, being the first for the Atlantic Forest.

***Fissidens pseudoplurisetus* Bordin, Pursell & Yano**
Figures 2J, K, 5A

Material examined. BRAZIL • 1 specimen; Rio Grande do Sul, São Francisco de Paula, Caconde 29°32′50″S, 050°28′20.53″W; 28 Jun. 2019; D.F. Nunes et al. leg.; old forest, tree trunk; HERW 2570. • 1 specimen; São Francisco de Paula, Caconde, 29°32′50″S, 050°28′20.53″W;

28 Jun. 2019; D.F. Nunes et al. leg.; forest in advanced stage of restoration, on rock and soil; HERW 2603.

Identification. Gametophyte medium (5–9 mm long); leaf completely limbated, limbidium triestratosus finishing well before the apex and well before insertion with stem in the dorsal lamina; cells unipapillose; sporophytes one to four per perichaetium. It differs from *F. angustifolius* because it has leaf lanceolate to linear-lanceolate, palm arranged and from *F. goyazensis* because it has a limbidium confluent with the costa, which is usually excurrent.

Phytogeographic domain. Atlantic Forest.

Comments about geographic distribution. *Fissidens pseudoplurisetus* was described in 2011 and is endemic to Brazil, previously known only in the Atlantic Forest of São Paulo and Paraná, occurring as corticicolous, in branches of trees of Dense Ombrophilous Forest and Nebular Forest (Bordin et al. 2011; Santos 2016). This new record (Fig. 5A) is of great importance for the knowledge of the species because it indicates that it can occur in the whole area of the Atlantic Forest, or even in the Pampa. The region where it was collected, in the 30°S parallel, has a climate discontinuity and is characterized by having a transition between the phytogeographic domains of the Atlantic Forest and Pampa (Fiaschi and Pirani 2009).

The material examined, when compared to the original description (Bordin et al. 2011), presents a larger size of the gametophyte and limbidium, which is always triestratosus. The larger limbidium may be related to the wetter and higher altitude environment where the specimens were collected. Bordin and Yano (2013) reported that the same occurs with other *Fissidens* species such as *F. angustelimbatus* Mitt. and *F. curvatus* Hornsch., which present a more developed limbidium in specimens in wetter and higher altitude environment. Furthermore, the species was collected in soil and rock, increasing the knowledge about its biology, since it was previously reported only on tree trunks and branches.

Pylaisiadelphaceae

***Isopterygium subbrevisetum* (Hampe) Broth.**
Figures 2F, G, 5B

Material examined. BRAZIL • 1 specimen; Rio Grande do Sul, Torres, Itapeva State Park; 29°21′51″S, 049°45′ 03″W; 11 Dec. 2019; T.S. Dewes et al. leg.; restinga swamp forest, on decaying tree trunk; HERW 2314.

Identification. Gametophyte glossy-green; leaf distant not complanned; generally ecostate; alar region with one to three cells and absent pseudoparaphyllium.

Phytogeographic domain. Amazon and Atlantic Forest.

Comments about geographic distribution. This species is broadly distributed in Brazil, occurring in the Amazon and Atlantic Forest, from the states of Ceará to Santa Catarina (Flora do Brazil 2020), and presents a disjunct geographic distribution. The new record from Rio Grande do Sul fills a gap in the geographical distribution, and extends the southern limit of the species distribution (Fig. 5B).

Marchantiophyta
Cephaloziellaceae

***Cylindrocolea rhizantha* (Mont.) R. M. Schust.**
Figures 3A, 5B

Material examined. BRAZIL • 2 specimens; Rio Grande do Sul, Torres, Itapeva State Park; 29°21′51″S, 049°45′ 03″W; 9 Jan. 2019; T.S. Dewes et al. leg.; wetlands of the frontal dunes, sandy substrate; HERW 2274, 2275.

Identification. Underleaves lacking; leaves succubus, two-lobed, inserted laterally in the stem, acute to obtuse apex, ending with two or one cell.

Phytogeographic domain. Amazon, Cerrado, and Atlantic Forest.

Comments about geographic distribution. This species has a moderate and disjunct distribution in Brazil, occurring punctually in the Amazon (Acre), Cerrado, and Atlantic Forest. The new record from Rio Grande do Sul is the first from the South Region of Brazil, expanding the southern limit of the species (Fig. 5B). It is possible that *Cylindrocolea rhizantha* also occurs in the other states of this region and it is necessary to increase the collection efforts.

Lejeuneaceae

***Cololejeunea minutilobula* Herzog**
Figures 3B, C, 5B

Material examined. BRAZIL • 2 specimens; Rio Grande do Sul, Torres, Itapeva State Park; 29°21′51″S, 049°45′ 03″W; 24 Jan. 2019; T. S. Dewes et al. leg.; restinga sandy forest, on the hill trail, in leaves; HERW 2258, 2259.

Identification. Recognized by the elongated hyaline cells restricted to the apex of the lobe, vegetative leaf lobes reduced to a rectangular and flat structure of 10–20 cells.

Phytogeographic domain. Atlantic Forest.

Comments about geographic distribution. This species was previously known from São Paulo and Paraná, in areas of rainforest, with restricted distribution pattern. The new record expands its distribution to the south (Fig. 5B). In the present study, *C. minutilobula* was collected in an area of sandy forest, indicating that it can also be founded in other types of vegetation.

***Drepanolejeunea fragilis* Bischl.**
Figures 3D, 5B

Material examined. BRAZIL • 1 specimen; Rio Grande do Sul, Torres, Itapeva State Park; 29°21′51″S, 049° 45′03″W; 11 Jul. 2019; T.S. Dewes et al. leg.; restinga swamp forest, on decaying tree trunk; HERW2318.

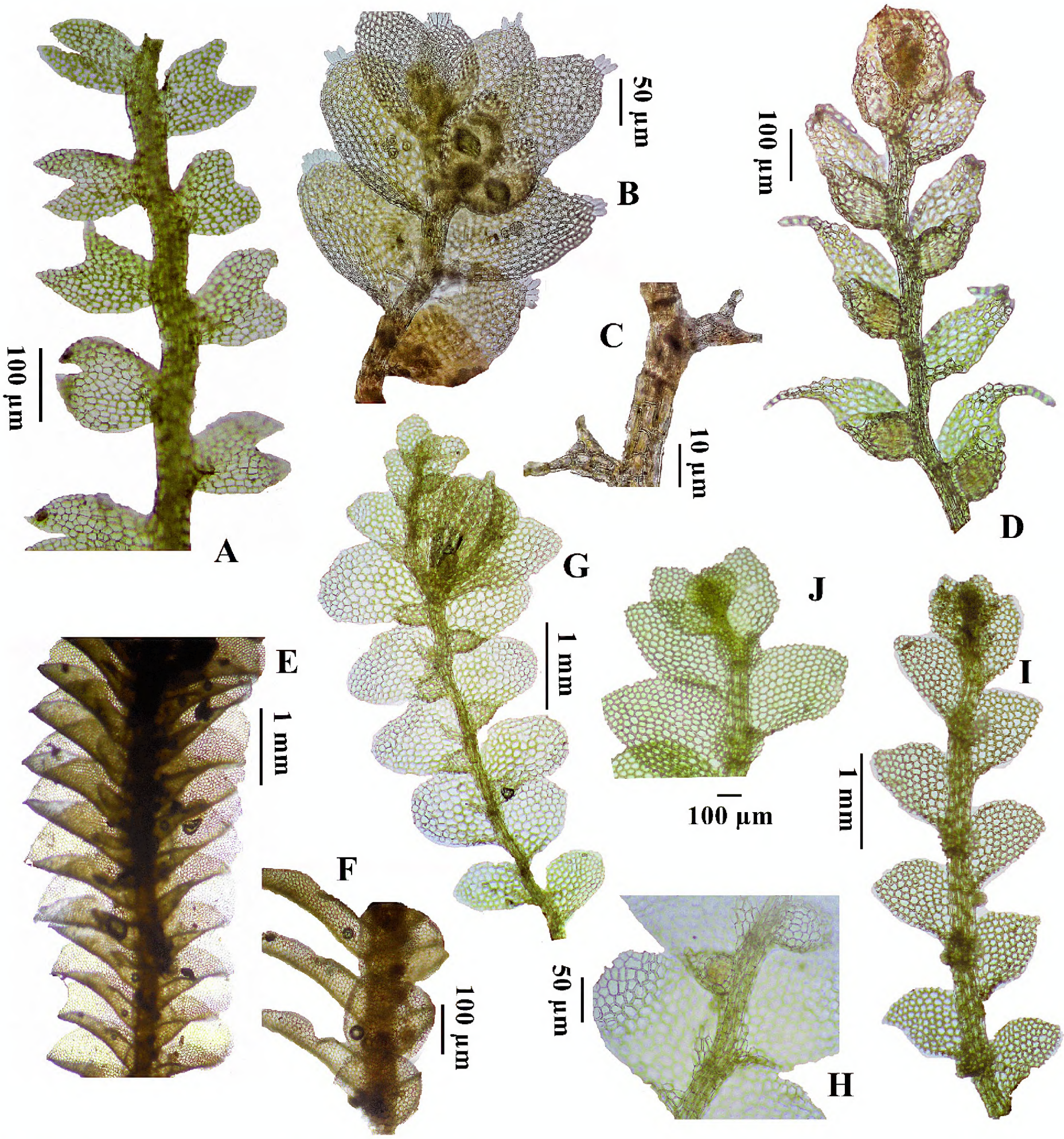

Figure 3. A. *Cylindrocolea rhizantha*, gametophyte. **B–C.** *Cololejeunea minutuloba*. **B.** Gametophyte. **C.** Detail of the lobule. **D.** *Drepanolejeunea fragilis*, gametophyte. **E–F.** *Frullanoides corticalis*. **E.** Gametophyte. **F.** Detail of the lobule and underleaves. **G–H.** *Lejeunea aphanes*. **G.** Gametophyte with perianth. **H.** Detail of the lobule and underleaves. **I–J.** *Lejeunea bermudiana*. **I.** Gametophyte. **J.** Detail of underleaves.

Identification. *Drepanolejeunea fragilis* can be recognized by the inflated lobes, falcated leaf, anterior margin of the lobe denticulated, and two or three ocelli spread on the leaf.

Phytogeographic Domain. Amazon and Atlantic Forest.

Comments about geographic distribution. This species is broadly distributed in Brazil and, occurring in the Amazon and Atlantic Forest, from the states of Ceará to São Paulo (Flora do Brazil 2020) and presents a disjunct distribution. The new record from Rio Grande do Sul is the first for the Southern Brazil (Fig. 5B).

***Frullanoides corticalis* (Lehm. & Lindenb.) van Slageren**

Figures 3E, F, 5C

Material examined. BRAZIL • 1 specimen; Rio Grande do Sul, Osório, APA Morro de Osório, 29°51.664′S, 050°16.821′W; 7 Feb. 2019; M. Ferri et al. leg.; stretch of creek, open forest, near the main road, on tree trunk base; HERW 2440. • 1 specimen; Osório, APA Morro de Osório; 29°50.410′S, 050°18.131′W; 13 Feb. 2019; M. Ferri et al. leg.; stretch of creek, near the main road, on tree trunk base; HERW 2484.

Identification. Gametophyte up to 1.5 mm; blackish color, underleaves without auricules, and lobules with four to six short teeth.

Phytogeographic domain. Amazon, Cerrado, and Atlantic Forest.

Comments about geographic distribution. This species presents a restricted and disjunct distribution in Brazil, occurring punctually in the Amazon (Roraima), Cerrado and Atlantic Forest. The new record from Rio Grande do Sul is the first of the Southern Brazil (Fig. 5C) The Environmental Protection Area of Morro de Osório is at the southern limit of the Atlantic Forest (*sensu strictu*), which suggests that this may be the southern limit of the species distribution.

***Lejeunea aphanes* Spruce**
Figures 3G, H, 5C

Material examined. BRAZIL • 1 specimen; Rio Grande do Sul, Torres, Itapeva State Park; 29°21′51″S, 049° 45′03″W; 9 Jan. 2019; T.S. Dewes et al. leg.; restinga sandy forest, on tree trunk; HERW 2288.

Identification. Recognized by the small, distant underleaves, well adhered to the stem, with not very distinct margins, V-shaped sinuses, and whole perianth keels.

Phytogeographic domain. Atlantic Forest.

Comments about geographic distribution. This species has a restricted distribution pattern, previously known only from the Northern Brazil (Bahia and Ceará), in areas of Atlantic Forest. The new record is the first from the Southern Brazil (Fig. 5C), reveals a disjointed and rare pattern of distribution, and indicates that it may occur in other areas with similar microenvironments.

***Lejeunea bermudiana* (A. Evans) R. M. Schust.**
Figures 3I, J, 5C

Material examined. BRAZIL • 1 specimen; Rio Grande do Sul, Torres, Itapeva State Park; 29°21′51″S, 049° 45′03″W; 25 Oct. 2018; T.S. Dewes et al. leg.; restinga sandy forest, on the hill trail, on tree trunk; HERW 2164.

Identification. Recognized by the contiguous to imbricated leaves, with slightly toothed apex and distant, oblong to rounded underleaves.

Phytogeographic domain. Amazon, Caatinga, and Atlantic Forest.

Comments about geographic distribution. This species presents a disjunct distribution in Brazil, occurring in the Amazon, Caatinga, and Atlantic Forest (from Bahia to São Paulo, except Minas Gerais). The new record, from an area of restinga sandy forest, is the first from the South Region of Brazil (Fig. 5C). This species is expected to occur in similar areas and a greater collection effort is required.

***Lejeunea laeta* (Lehm. & Lindenb.) Gottsche**
Figures 4A, 5C

Material examined. BRAZIL • 3 specimens; Rio Grande do Sul, Torres, Itapeva State Park; 29°21′51″S, 049°45′03″ W; 11 Jul. 2019; T. S. Dewes et al. leg.; restinga swamp forest, on tree trunk; HERW 2334, 2336, 2341.

Identification. Recognized by imbricate and oval leaves, with entire margin and underleaves rounded to orbicular.

Phytogeographic domain. Atlantic Forest.

Comments about geographic distribution. This species is moderately distributed in Brazil, occurring only in areas of Atlantic Forest, from Ceará to Santa Catarina. The new record from Rio Grande do Sul fills an important gap in the geographical distribution and extends the southern limit of the species distribution (Fig. 5C).

***Lejeunea monimiae* (Steph.) Steph.**
Figures 4B, C, 5D

Material examined. BRAZIL • 1 specimen; Rio Grande do Sul, Torres, Itapeva State Park; 29°21′51″S, 049° 45′03″W; 22 Nov. 2018; T. S. Dewes et al. leg.; restinga sandy forest, on the hill trail, on decaying tree trunk; HERW 2230.

Identification. Recognized by generally fertile gametophytes, large underleaves, two or three times larger than stem, rectangular lobes, with involute margins and cells with small trigones.

Phytogeographic domain. Atlantic Forest.

Comments about geographic distribution. This species presents moderate and disjunct distribution in Brazil, occurring in areas of Atlantic Forest. The new record fills an important gap in the geographical distribution, extending its southern limit (Fig. 5D).

***Microlejeunea subulistipa* Steph.**
Figures 4D, E, 5D

Material examined. BRAZIL • 1 specimen; Rio Grande do Sul, Torres, Itapeva State Park; 29°21′51″S, 049°45′ 03″W; 11 Jul. 2019; T.S. Dewes et al. leg.; restinga swamp forest, on tree trunk; HERW 2345.

Identification. Apex of the lobe with concavity and underleaves lobes ending with two cells.

Phytogeographic domain. Amazon and Atlantic Forest.

Comments about geographic distribution. This species presents a disjunct geographic distribution in Brazil, occurring occasionally in the Amazon and the Atlantic Forest of four states: Amazonas, São Paulo, Rio de Janeiro, and Santa Catarina (Flora do Brazil 2020). The new record from Rio Grande do Sul expands the distribution of this species to the south (Fig. 5D). It is possible that *M. subulistipa* occurs in other areas but has not been collected due to its small size.

Metzgeriaceae

***Metzgeria consanguinea* Schiffn.**
Figure 4F, 5D

Material examined. BRAZIL • 1 specimen; Rio Grande do Sul, Osório, APA Morro de Osório; 29°52.635′S, 050°

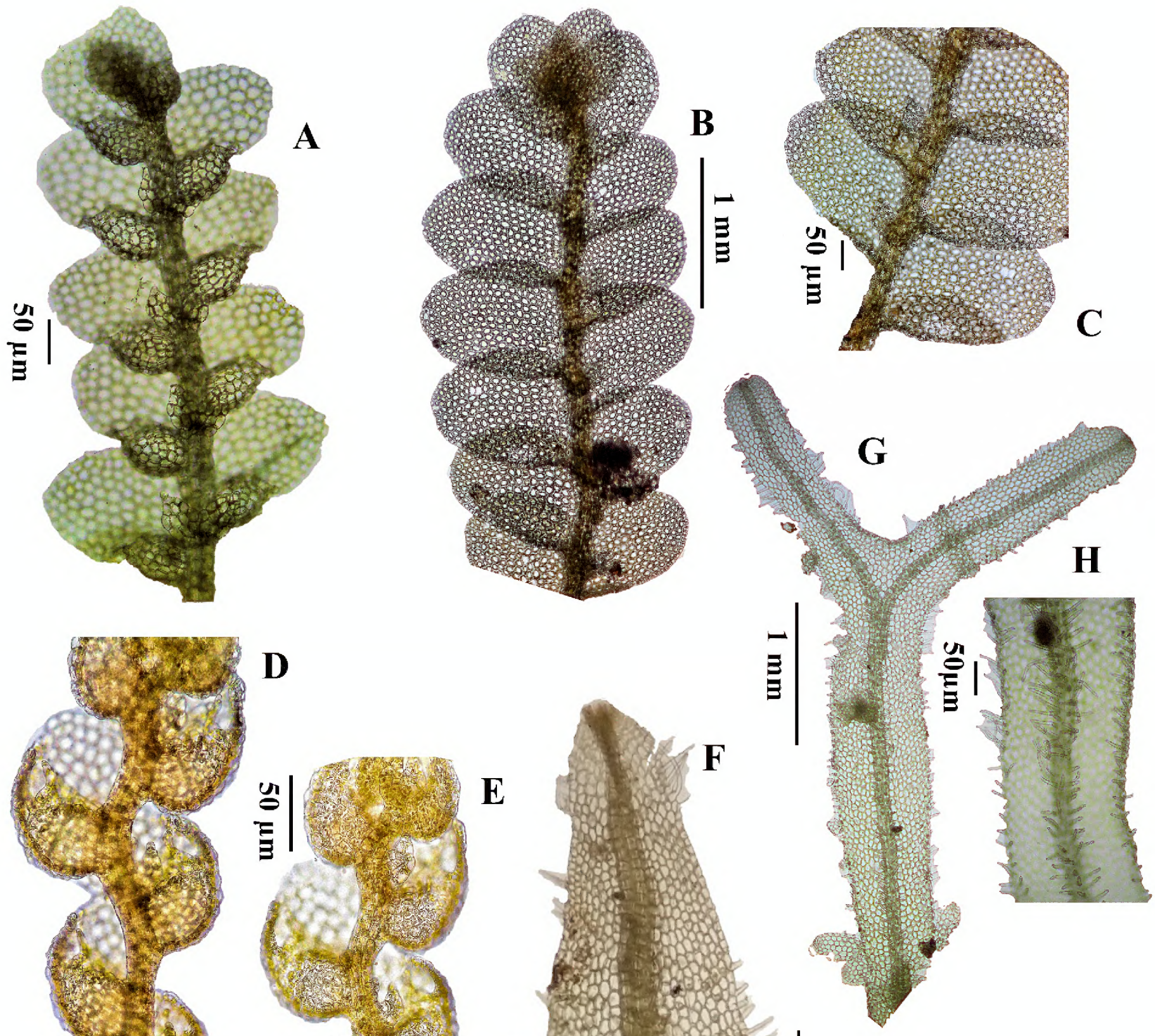

Figure 4. A. *Lejeunea laeta*, gametophyte. **B, C.** *L. monimiae*. **B.** Gametophyte. **C.** Detail of lobule and underleaves. **D, E.** *Microlejeunea subulistipa*, gametophytes. **F.** *Metzgeria consanguinea*, detail of the thallus and hairs. **G, H.** *Metzgeria rufula*. **G.** Gametophyte. **H.** Detail of the hairs.

15.073′W; 7 Feb. 2019; M. Ferri et al leg.; stream spring, on tree trunk, at 1.6 m height; HERW2426. • 1 specimen; São Francisco de Paula; 29°32′50″S, 050°28′20.53″W; 28 May 2019; D.F. Nunes et al. leg.; forest in advanced stage of regeneration, on tree trunk; HERW2613.

Identification. Recognized by the medulla with more than 15 cells (19–24), flat to slightly convex thallus, strongly attenuated at the apex, forming a flagellum, and marginal gemmae at the apex of the branches.

Phytogeographic domain. Atlantic Forest.

Comments about geographic distribution. *Metzgeria consanguinea* was previously known from areas of Atlantic Forest in the states of Rio de Janeiro, São Paulo, and Paraná (Costa 2008; Flora do Brazil 2020). The new record from Rio Grande do Sul extends the southern limit of distribution of this species (Fig. 5D).

Metzgeria rufula Spruce

Figures 4G, H, 5D

Material examined. BRAZIL • 2 specimens; Rio Grande do Sul, Torres, Itapeva State Park, 29°21′51″S, 049°45′03″W; 22 Nov. 2018; T.S. Dewes et al. leg.; restinga sandy forest, on the hill trail, on tree trunk; HERW 2281, 2284.

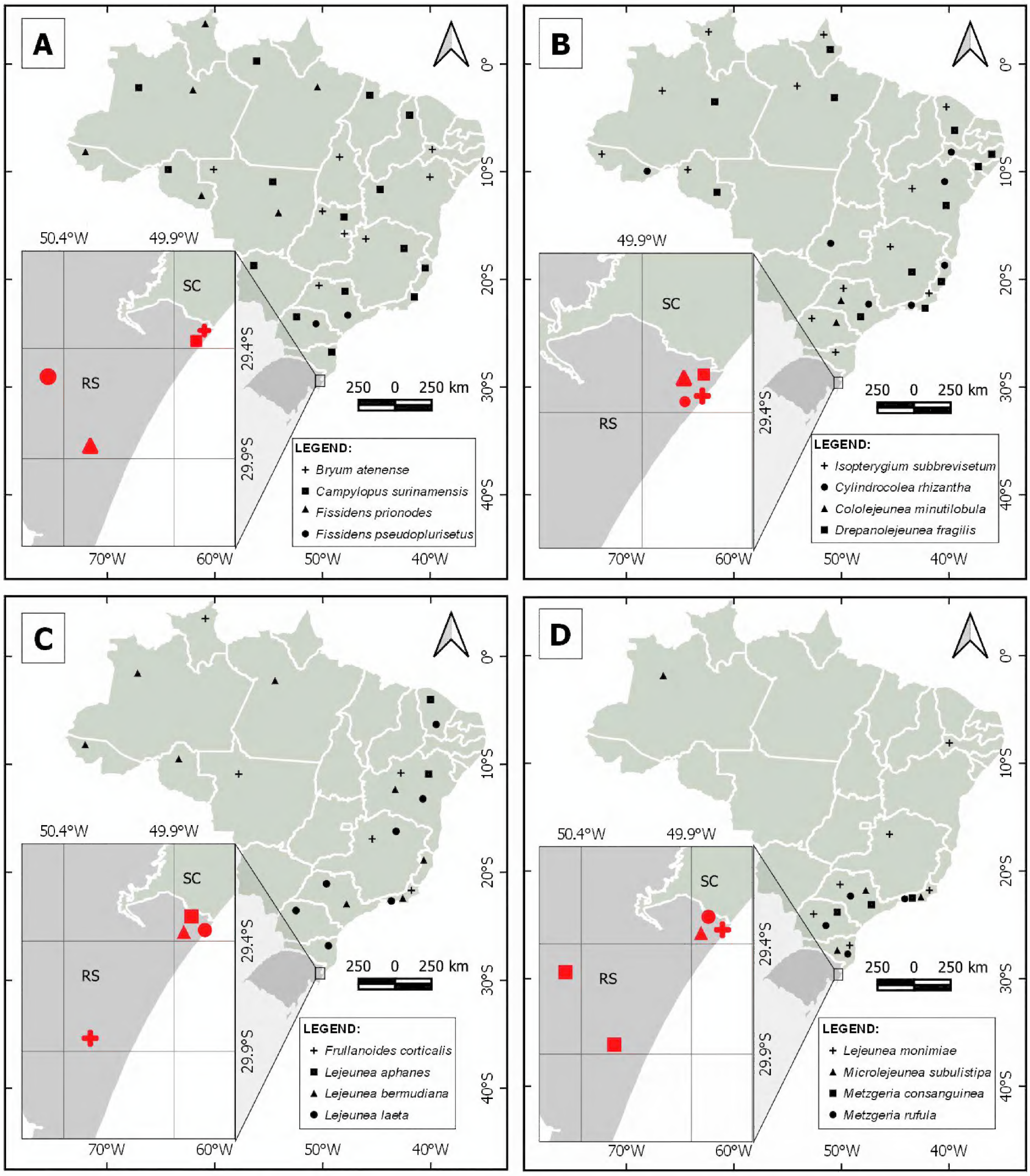

Figure 5. Map of the geographic distribution of the species in Brazil (black symbols) and new records for Rio Grande do Sul (red symbols). **A.** *Bryum atenense*, *Campylopus surinamensis*, *Fissidens prionodes*, *Fissidens pseudoplurisetus*. **B.** *Isopterygium subbrevisetum*, *Cylindrocolea rhizantha*, *Cololejeunea minutuloba*, *Drepanolejeunea fragilis*. C. *Frullanoides corticalis*, *Lejeunea aphanes*, *Lejeunea bermudiana*, *Lejeunea laeta*. **D.** *Lejeunea monimiae*, *Microlejeunea subulistipa*, *Metzgeria consanguinea*, *Metzgeria rufula*.

Identification. Recognized by the wide thallus (1 mm wide), bordered with differentiated cells, and the falcated eyelashes, one to three per margin cell.

Phytogeographic domain. Atlantic Forest.

Comments about geographic distribution. This species was previously recorded from areas of Atlantic Forest, in diverse environments, including urban areas (Flora do Brazil 2020). The new record expands the species distribution to the Southern Region (Fig. 5D).

Discussion

Floristic inventories have important roles in understanding plant biology and ecology (Brundu and Camarda 2013), allowing the classification of phytogeographic domains (Moro et al. 2014), the assessment of conservation status, and facilitating forecasting temporal and spatial changes in plant communities. Floristic studies can be used to assess species richness along distance gradients from the sea (Sundberg et al. 2006; Silva et al. 2014),

and the geographic distribution patterns of species can be used to infer the effects of niches on the compositions of plant assemblages (Germano et al. 2016).

New occurrences of bryophyte species are being constantly published around the world (Vital and Visnadi 2000; Kirmaci et al. 2012; Ellis et al. 2014, 2017; Erata and Batan 2019). In Brazil, new occurrences are recorded for several phytogeographic domains (Souza et al. 2017; Nascimento et al. 2019; Sierra et al. 2019). Currently, 1,337 species of bryophytes are known to occur in the Atlantic Forest (Costa and Peralta 2015). Nevertheless, new occurrences of bryophytes and even new species are constantly recorded (Bastos 2011; Souza et al. 2017; Santos et al. 2018; Abreu and Oliveira 2019; Amélio et al. 2019).

Of the 16 species recorded in this study, 12 were collected in the municipality of Torres, extreme north of the coast of Rio Grande do Sul. This region constitutes an important connection and migration corridor of the tropical flora of the Southeast (Dense Ombrophylous Forest) with the plateau of the Serra Geral National Park, shared by both Santa Catarina and Rio Grande do Sul states (Rambo 1950), data also corroborated by palynological studies (Lorscheitter 2003). The coastal vegetation that grows in sandy substrate is commonly called restinga, or pioneer vegetation, and corresponds to a phytophysiognomy of the Atlantic Forest domain. The species that live in this environment are adapted to a high variation in the ecological conditions of sunshine incidence, water availability, saline and wind stress, and nutritional scarcity (Leite and Klein 1990; Scarano 2002; Fiaschi and Pirani 2009).

The new bryophytes records fill important gaps and expand the range of distribution of these species, since many were known only in the Atlantic Forest, and some had the state of Santa Catarina as their southern limit. For example, *Fissidens prionodes* was previously known from the Amazon region and is first mentioned to the Atlantic Forest.

The new records in a different geographic region and/or environment contribute to develop the knowledge environmental needs of the species and to study the variation in environmental requirements throughout the geographic range (Soderström et al. 1992). They also allow understanding of the variation patterns of beta diversity through the analysis of floristic composition between regions, one of the central questions of ecology (Bates 1982).

This work fill gaps in the geographical distribution of 16 species and provides subsidies for the development of other studies related to biogeography, conservation biology and ecology. Frahm (2003) and Glime (2018) consider that taxonomic studies such as checklists are essential for studies on diversity and geographical differences. The description of the spatial distribution pattern of the species and the understanding of the processes by which these distributions were achieved is the central point of biogeography (Vanderpoorten and Goffinet 2009).

In relation to conservation biology, the new records contribute to the two first steps of the conservation process established by Soderström et al. (1992): recognize and list rare and decreasing species, and record their distribution, biology and threats. Hallingbäck and Hodgetts (2000) consider the geographical range of species one of the most important criterion in Red Lists.

These new records demonstrate the importance of floristic inventories to increase the knowledge of the biodiversity of Brazil and the Atlantic Forest. It also corroborates the need for more collections in the state of Rio Grande do Sul, since the new records published by 99% of the recent papers (Bordin and Yano 2009a, 2009b; Heidtmann et al. 2013; Weber et al. 2014; Aires et al. in press) have indicated that the bryodiversity of the state is underestimated and still poorly known.

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Authors' Contributions

JB and TSD collected, identified the specimens and wrote the manuscript; DFP confirmed the species identification, wrote the manuscript, made the illustrations; MF and BRR collected and identified the specimens.

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